them to the Yarra. But the main pipes are not yet laid, except for a very short distance; and, therefore, I do not see that it is too late to lay them in another direction, where we shall find at all times the purest water in the most unlimited abundance.

But, while I am of opinion that the pipes ought not to be laid, I am most anxious that the capabilities of the reservoir should be tested before finally abandoning it; and, for this purpose, I hope that the aqueduct will be completed in time to take advantage of the winter rains.

I may also notice that no steps have yet been taken to convey the two branches of the river through the swamps. This will cost a very large sum, and of course is not yet contracted for.

It is deeply to be regretted that a work of such magnitude and importance as that which forms the subject of this paper should be found to be based on incorrect scientific principles; and it shows the vast importance of cultivating the sciences, even in this remote corner of the globe.

Had there been a scientific society in this city two years ago, the Commissioners might have obtained more correct information respecting the rate of evaporation in this colony, and more certain and reliable data with respect to the watershed of the Plenty basin; which were so necessary to ensure the success of their scheme.

It was purely on scientific grounds that I was induced to undertake the investigation of this subject; and it was the conviction of its great importance, in a scientific as well as in a sanitary point of view, that has led me to submit to you the result of my inquiries.

If there is any probability of the Yan Yean Reservoir scheme failing for want of water, the sooner this unfortunate result is discovered the better.

It would surely add little to the scientific reputation of Victoria, that a work of such magnitude should be allowed to be completed, at a ruinous sacrifice of public money, before its failure is even suspected.

ART. XIII.—*The Meteorology of Melbourne. By* DR. E. DAVY.

MY attention during a part of the last four months having been directed to the meteorology of this place, I propose to lay before this Society the result of the observations I have made, the inferences which appear to be deduceable from them, and particularly in regard to the nature of the hot winds.

Referring to the journal which I have kept since the 1st of December, I must first briefly advert to the thermometric observations. It will be seen that the highest point reached by the thermometer has been 112°, in the shade, and the lowest 45° in the night. There has been no night on which the thermometer has not sunk to 74°. We have therefore had none of those very hot or very cold nights, such as are not uncommon in the summers of South Australia:—and the heat, though on some occasions very intense, has in no instance been very continuous.

The mean monthly temperature has been estimated in two different ways:—First, by averaging the sum of the daily highest and lowest readings of a Sike's thermometer. Secondly, by exposing to the air in the shade a copper vessel, containing ten gallons or more of water, closely covered to prevent evaporation, and taking the temperature of this water twice a day, viz. at 6 a.m. and 6 p.m. The results of these two methods of observation have been found during December and January to correspond within a single degree. The mean temperature of December was 68°, and that of January 70°, and that of February 69°, and of March 68°; being ten degrees above the mean of the corresponding summer months in London in 1844. On the two days when the thermometer stood about an hour after noon at the highest point, 112°; viz., on the 28th and 29th January, it sunk in the course of the night to 66½° and 66°; thus showing a range of 46° during the twenty-four hours.

My observations on the barometer have not been sufficiently complete to admit of calculating with precision its mean height. I have recorded the reading of the barometer every day about noon; and during changes of weather, I have observed it at all hours; but not at other times. Approximatively, the reading was for December, 29·82; January, 29·88; February, 30·0.

The hygrometric observations are of more immediate interest and practical importance. They have been made principally with a Mason's hygrometer, the accuracy and convenience of which is now generally admitted. It appears that the mean dew point of December was 50·0; that of January, 49·5; and that of February, 50·3; having thus been practically the same during the three months. I have made these observations on numerous occasions at all hours, from six in the morning till late in the evening, and have not found them to differ materially from those made daily about noon, the dew point having been nearly the same during the continuance of brisk wind in the same direction. Deducting the dew point from the mean temperature, gives the dryness of December 18°; that of January, 20·5°; and that of February, 18·7°. The mean of the three is 19·0°, while that of England is 8·0°. Thus the dryness of summer in Melbourne is to that of London, as more than 2¼ to 1; as far as the present season only is concerned.

The total rain fallen during the four summer months,—December, January, February, and March, was 4·67 inches. I may here be permitted to suggest a caution against any deductions from the annual rain-fall of Melbourne being applied to places even at twenty or thirty miles distance. It is well known that in England the annual rain-fall in some places is more than double of that which occurs in London.

During the four months in question there has been no appreciable deposit of dew in Melbourne. While on this subject, I may refer to the fallacy of supposing that dew is ordinarily deposited on the surface of water as it is upon that of the land. To attract dew, the surface must be cooled down to the dew point. This on the land is effected by *radiation*, but not so with the water surface. The cooling effect of evaporation will never reduce the temperature more than half way down to the dew point. A careful consideration of circumstances will convince us, that a deposition of dew upon the surface of deep unfrozen water must be a very rare, and almost inconceivable event in this colony.

The rate at which evaporation will take place from the surface of water depends essentially upon three circumstances,—

1st. The actual temperature.

2nd. The degree of dryness of the air.

3rd. The velocity of the wind.

It will, however, be difficult from these data alone, to calculate otherwise than approximatively the true rate of evaporation. Nothing short of direct experiment is to be depended upon; and even direct experiment upon a small scale is liable to a slight degree of fallacy.

With respect to the temperature there are two observations to be made:—1st. It is the temperature of the air rather than that of the water which affects the result. The air, on coming in contact with the water, raises or depresses as the case may be, almost instantly to a certain temperature, an infinitesimally thin film of water, and it is from this surface film that the evaporation takes place, however cold the water below may be. This certain temperature will be nearly midway between the actual temperature of the air and its dew point. It is true that the air itself may not only become cooled, but also partially saturated with moisture on passing over a very large surface of water, but in this case, the thermometer and hygrometer ought to indicate a notable difference on the windward and lee sides of the sheet of water. 2nd. The rate of evaporation, as far as it depends on temperature, will be affected rather by the range of the thermometer than by its mean. Inasmuch as the tension of vapour increases almost in a geometrical ratio to the increase of temperature, it is easy to see that if a surface of water were exposed for twelve hours to a temperature of 50° and for another twelve hours to 90° it would evaporate more rapidly than if exposed for the whole twenty-four hours to the mean of 70°. Hence I suppose that evaporation will be more rapid in Melbourne, as compared with London, than the mean temperature alone would indicate. 3rd. The evaporation from any given area of *wet land*, will be greater in proportion than from a similar area of a sheet of water, because it exposes a greater surface.

By direct experiments upon water in different vessels and under different circumstances, exposed to the air during the months of January, February, and March, and comparing these with the hygrometric observations made also in December, I am led to estimate the mean evaporation of the three summer months of December, January, and February, as 0·55 per day, or four feet one and half inches. I have no certain data from which to infer what it may be during the remaining nine months of the year; and would not, therefore, except in the absence of precise information, presume to offer an estimate as a matter of opinion founded upon general observation. I cannot suppose that the evaporation during the six months of spring and autumn, viz:—March, April, May, September, October, and November, is less than half of that which occurs in summer; and I assume that of the three winter months, viz:—June, July, and August, to be one-fifth. We shall thus have

Summer	4	1½	
Spring and Autumn ...	4	1½	
Winter		9	
	9	0	feet.

It may be greater; but is not likely to be much less than is here estimated; and it may be a question whether this present season has or has not been below the average in point of dryness.

The evaporation on the eighteenth of February was more than one inch; the dew point at noon being 37° the mean temperature being 78°, the range 42°, and the highest 99°.

I may here state the formula which is given in scientific works for calculating the rate of evaporation from the temperature of the air and its dryness. Water at 212° is ascertained by careful experiments to evaporate at the rate of 0·725 grain per square foot per minute. By referring to Dalton or Ure's tables, the tension of watery vapour at any given temperature can be found. Let T be the tension at the temperature of the air, and T″ the tension at the dew-point, than by a simple rule of three sum,

$$\text{As } 30 : 725 :: T - T'' : x$$

x being the answer in grains per square foot per minute, from which the quantity in inches can readily be calculated.

This rule however affords us no guide for estimating the ratio of increase from the action of wind in proportion to its velocity.

The experiments which I have made on the rate of evaporation can easily be repeated by other persons, and I have no doubt that the correctness of the results, considered as approximative will eventually be fully confirmed. But of course it is not intended to represent that the level of every natural water hole will sink at the rate of half an inch per day in the summer months, because the contrary is well known. The adjacent soil may be porous and become saturated with water which is altogether protected from evaporation. This water would of course return into the pool, and supply the place of that which had been dissipated by evaporation from the exposed surface. It is probably only in cases where the sides and bottom of the pool consists of impervious clay, that the level of the water would sink in anything like the proportion I have mentioned.

I have now to speak of the winds of Melbourne; and it will be seen on reference to the Journal, that the prevalent winds are those from the south, or within a few degrees of south. The next in frequency are those from the north and north-west. Winds from all other points of the compass occasionally blow, but are not of long duration. It will, I think, presently appear that this is just what might have been expected on theoretical grounds. Before however explaining my particular views on this subject, it will be necessary to introduce a brief reference to the phenomena of winds generally, and their causes as far as they are well understood. Winds arise from the circumstance that different portions of the earth's surface are unequally heated, and that air expands and becomes lighter in proportion as its temperature is increased. The air in contact with the overheated surface has of course a tendency to ascend, and a partial vacuum being thus induced, the air from the cooler regions in the vicinity flows towards that point. In order to destroy the equilibrium, it is manifest that the heated air, after having ascended to a certain height, must flow off again horizontally, in a direction opposite to that in which it moved at the surface.

It is on this principle, that the great comparative heat of those portions of the earth within the tropics causes a constant flow of air from the poles towards the equator at the earth's surface and a current from the equator towards the poles in the upper regions of the atmosphere. But in consequence of the motion of the earth in its rotation on its axis being greater in proportion as we approach the equator, the north and south currents of air at the earth's surface become converted into north-easterly and south-easterly, and, from the converse operation of the same cause, the upper currents returning from the tropics become north and south-westerly. All up to this point is so well understood and appears to be so simple that it almost needs an apology for its introduction into a paper of this description; but, as we further pursue the study of the winds, we shall find that they become modified by the utmost complexity of causes. We shall have to deal with some facts difficult to explain, and with others which defy all our powers of calculation; so that the scriptural saying in reference to the wind, "Thou canst not tell whence it cometh or whither it goeth," is still true in the present state of our scientific and geographical knowledge.

From what has been above stated, it might be supposed that, irrespectively of local influences, the general tendency of the winds at the earth's surface in all latitudes should be north and south-easterly. The fact however is, that beyond a certain limit outside the tropics, the prevailing winds are more or less westerly. Explanations of this fact are to be found in different treatises upon the subject; but I have not seen any that entirely meets the case. It appears to me that the fact may be accounted for by the greater amount of friction and resistance to the wind which occurs at the earth's surface than in the upper and free regions of the atmosphere. From the influence of this cause it is easy to understand that the upper current of air would retain its velocity or momentum in its progress to the poles, so as to be enabled at a certain distance from the tropics to overcome the more sluggish lower current, and force it into its own direction. It is evident that the current of air towards the poles can only be equal to that which is flowing towards the equator; I suppose, therefore, that in the belt in which the westerly winds prevail, the upper current has overcome the lower, only by communicating its own westerly and not its southerly direction.

With respect to the winds of Australia it is to be observed that we have a very large island or continent, of a compact form, not deviating greatly from that of a circle, and for the most part remote from any other large tract of land. Of this immense region a part is situated within the tropics, and the remainder very close outside the tropics, so that, having much higher temperature than that of the surrounding ocean, the land may be considered as a vast heating surface, which, on the principles already explained, will have a tendency to draw currents of air in all directions towards its centre of heat. There can be no doubt that the hottest part of the island exists to the northward, and probably also to the westward of the geographical centre. The influence of the trade winds within the tropics would probably throw this point towards the west; and, in confirmation of this view, I would observe that the hottest part of the ocean in the vicinity is south of the line, and to the N. W. of Australia, according to Black's map of Physical Geography:—viz. Java and Timor. For the sake of illustration, we will suppose the hottest point to be in long. 130° and lat. 22° or a little to the N. W. of Sturt's Desert. Confining our investigations to the southern portions of the continent, we have next to consider that the wind, blowing outside the coast, has a prevailing direction from west to east, and therefore on approaching the coast it would not at once assume a direction towards the centre of heat, but rather a direction intermediate between that and its original eastward motion.

On proceeding along the line of coast from west to east, we shall expect, on this principle, to find the westerly character of the wind gradually diminished, and that it will at a certain point become southerly, and beyond that again more or less easterly. Thus in South Australia the prevailing winds ought to be

S. W., and in the vicinity of Melbourne almost due east, and still further on south-easterly, and this we find in point of fact to be the case.

It is to be presumed that in the upper regions of the atmosphere, far above the level of the clouds, the returning current of air is almost constantly flowing in the opposite direction to that of the wind which prevails at the surface; that, in fact, the north wind is always blowing over our heads. So long as the pressure of wind from the south is sufficient, as indicated by the barometer standing high, a hot wind, according to my observation, does not generally occur. But let the barometer sink one or two tenths below its previous elevation, and the partial vacuum, of which this is the symptom, is liable to be immediately filled by the air nearest at hand, which is that overhead; and it continues to blow until the barometer either again rises, or else sinks still lower. In the former case, there will be first a lull and then a rapid return of the southerly wind; in the latter case, which, as I suppose, indicates that the hot wind has blown to a certain distance out to sea before it is met by the southerly wind, there will be rain, and the north having counterbalanced the south direction, the wind will be rather westerly. If the barometer be high, it indicates a tendency to efflux of air in all directions, and no immediate recoil, producing storms or rain, is to be expected.

It is a very common thing to speak of the hot winds as though they had blown to us direct from the interior desert, horizontally over the surface of the land. I have even read of a proposition to dam up rivers, so as to form artificial lakes towards the north, in order to mollify them. Such a view of the case is, however, totally irreconcilable with observed facts.

In the first place, a remarkable feature in these hot winds is their extreme dryness. The meteorological journal will show that the dew-point of a north wind, when blowing strongly, is always very low, sometimes as low as 35°. This wind is drier than that which would blow from the sea in any direction, and especially from the north at the corresponding season of the year. Air may be heated, but cannot be rendered drier, it cannot be deprived of its moisture by contact with hot sand, however dry. Seeing, therefore, that there are no elevated mountains toward the north, we are led to conclude that this air has been dried simply by having risen into the higher and colder regions of the atmosphere, where its moisture has separated in the form of clouds. This character of dryness is not peculiar to the hot winds of Australia. In the Deccan the wind has been seen at 90°, while the dew-point has been as low as 29°, or 3° below the freezing point, making the degree of dryness 61°

To some persons the doctrine that a hot wind should come from a cold quarter may appear paradoxical. This is not the occasion on which it is necessary or proper to discuss the elementary principles of chemistry or natural philosophy. I may, however, state that air when expanding in consequence of mere diminution of pressure, becomes cold independently of any heat being absolutely abstracted from it: its heat merely becoming latent; and it acquires its original temperature by simply restoring the pressure which previously existed. The experiment of igniting tinder by pressing cold air in a syringe is sufficiently familiar to every one; and the freezing temperature produced by the sudden expansion of air let out of a vessel in which it has been condensed is equally well known. In fact, the cold which exists on the tops of high mountains is attributable solely to the rarefaction of the air in those situations.

If the rationale of the hot winds, as above recited, be the true one, it becomes easy to understand why it is that hot winds occasionally occur in Van Diemen's Land and in the Island of Sicily, raising the thermometer above 100°, notwithstanding the great width of the intervening sea, which might be supposed to have exerted such a cooling influence as to have rendered such a temperature impossible.

Barometric observation appears to show that hot winds originate, not so much from an increase above the average in the pressure of the currents from the north, as from the diminution of pressure from the south and west. To account for this, I must refer to a previous remark as to the comparative friction and resistance in varied directions which exists at the earth's surface. From the absence of this influence in the upper currents of air, and for other reasons, it is legitimate to infer that they should be of a much more uniform character, and preserve more nearly a mean pressure; and hence we find that they do not occur when the barometer is either at its maximum or its minimum.

A northerly wind is frequently, and except during the middle of summer, almost invariably followed by rain. This circumstance at one time appeared to countenance the idea of an inland sea. It admits however of a very different explanation; bearing in mind, that from a variety of causes, the irregularity of the earth's surface, and the meeting and crossing of independent currents of air, the winds have a tendency to blow in curves, both horizontal and vertical, rather than in straight lines.

When a hot wind blows out to sea, it is cooled by contact with the water; but, at the same time, in consequence of its elevated temperature, it induces rapid evaporation, and becomes loaded with moisture. In proportion to the fall of the barometer, indicating the greatness of the vacuum which originally caused the descent of the hot wind, and the deposition of moisture occurring at the line of its meeting with the southerly wind, will be the tendency of the southerly and westerly winds eventually to become set in motion, in order to restore the equilibrium. The meeting of the cold with the hot wind, both comparatively loaded with moisture, will cause an immediate deposit in the form of clouds and rain. We have in fact the hot wind blown back upon us, after having been to sea, as it were, to bring back water.

We are apt to complain of these hot winds as one of the principal inconveniences of the climate. Had we however no hot winds, we should probably have little or no rain. The southerly winds would not bring it, because as they proceed northward they become warmer and drier, and have less and less tendency to deposit their moisture. Even the winter rains are usually the consequence of a northerly, although we do not at that season call it a hot wind.

The great redeeming feature of the Australian hot wind, is its low dew-point, or in other words, its dryness; but for this it would be intolerable. It is easy to conceive that with the thermometer at 112° and the air nearly saturated with moisture, profuse perspiration would be caused, but it would not be removed from the surface of the body, and the effect on the system would be nearly the same as if it were immersed in a scalding hot bath. It were vain to hope, and wrong to wish, that the hot winds of Australia should ever be abolished. But much may be done in the next generation to mitigate their inconvenience. The cultivation of the land, and especially the extensive planting of trees, will have some influence. The leaves of trees and shrubs act almost as wet cloths suspended in the air, and the cooling effect of evaporation from their surface is very considerable; added to which, is the probable cold produced by the absorption of carbon, by which an effect, the reverse of that produced by its oxidation or combustion, may be produced. The coolness of ripening fruits may perhaps be accounted for on this principle. The construction of houses, whether in adaptation to the exigencies of the climate or otherwise, of course depends on the will of private proprietors, and all that can be done in this particular, appears to consist in the erection of model dwellings, to show in what manner increased comfort may be obtained, without great increase of cost. But in the laying out of townships, and the planning of streets, it appears to me that the aspect, with reference to prevailing winds, ought to be taken into consideration, and that if this were duly regarded, the nuisance of dust might in a great measure be avoided. The streets and apppoaches might, to a certain extent, be so laid out as to direct the dust, by the shortest channels, off the town altogether. And this, in a district where the prevailing strong winds have so constant a character, would not, as I conceive, be attended with any particular difficulty.

Before bringing this paper to a close, I must briefly advert to the continued droughts to which some, at least, of the extra-tropical portions, of the continent of Australia are occasionally liable. In the Sydney district a drought has been known to continue for eighteen months together. The partial failure of the crops of last season in South Australia, appears to be attributable principally to the unusual deficiency of rain during the winter months of May, June, and July. Van Diemen's Land, notwithstanding its insular position, is not exempt from droughts. I am aware that I am now approaching the mysteries of meteorology: and it is not my intention to offer any bold hypothesis upon a subject which, in the present state of our knowledge, is undoubtedly inexplicable. It has by some writers been suggested, that these droughts are periodical, by which I understand that they should be liable to recur at stated intervals. I am not aware of any sufficient foundation either in theory, or in fact and observation, for such an opinion. There is no particular conjunction of the sun, moon, or planets, which could, upon any known principle, give rise to a drought. I know of no reason why we may not have a drought next year or the year after, without reference to the date of the last occurrence of such a calamity.

The droughts of Australia appear to be no more periodical than the tempests which, from time to time, and, fortunately at distant intervals, sweep the English and other coasts; and we ought at once to disabuse ourselves of this impression.

According to the principles proposed in a former part of this paper, the fall of rain will mainly depend upon the frequency and the extent of the alternations of the hot winds from the interior and the winds from the ocean. Supposing the wind to blow continuously in either one of these directions we should certainly have no rain. The dry north wind cannot deposit the wet which it does not contain. The sea breeze, coming from the south, has its tendency to absorb moisture increased as it proceeds northward, and will consequently give no rain.

If, therefore, we suppose that from whatever cause, at any time, there may be a more than usually steady current and uniform pressure in the ocean winds, off the Australian coast, we find at once, an adequate proximate cause for a drought on the land. As to the ultimate or remote cause, we have at present no data even for probable surmise, unless indeed we ascend another link in the chain of causes, and attribute the circumstance to the accidental absence of storms in the adjacent regions. On this subject at least a point is gained when a fallacy is cleared away. It is to be hoped that the result of simultaneous observations, which, under the patronage of the Board of Trade, are now about to be made at sea, in all parts of the world, will in due time throw a light upon this subject: I now conclude by recommending a co-operation in this important investigation, as one of the most legitimate objects to which the attention of the Philosophical Society could be directed.

ART. XIV.—*On the Probable Influence of Evaporation on the Quantity of Water to be supplied by the Reservoir at Yan Yean. By* CLEMENT HODGKINSON, C. E., *Survey Department.*

AT the last Meeting of the Philosophical Society, after Dr. Wilkie's Paper on the anticipated failure of the Plenty Scheme of Water Supply had been read, and your Committee's Report received, the President, in the course of a few terse and apposite observations, directed the attention of the members of the Society to the necessity of further elucidation of the phenomena connected with evaporation.

I quite concur in the President's opinion that the excessive difference in the estimated effects of evaporation on the surface of the Upper Plenty District by Dr. Wilkie and your Committee, calls for further investigation.

For Dr. Wilkie, on the authority of Thompson's computa-